

LAAS Siting Activity: Tilted Ground Model

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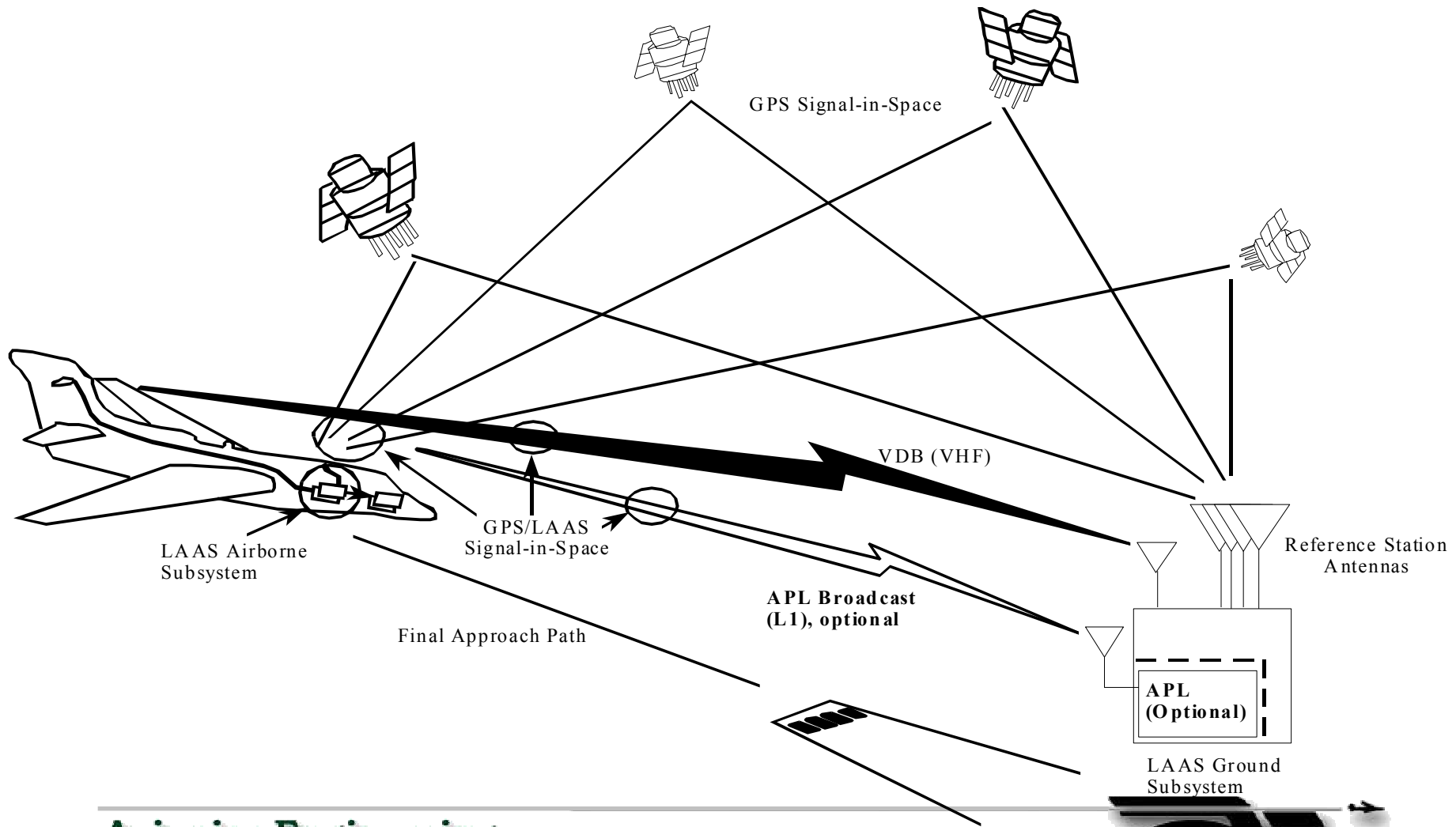
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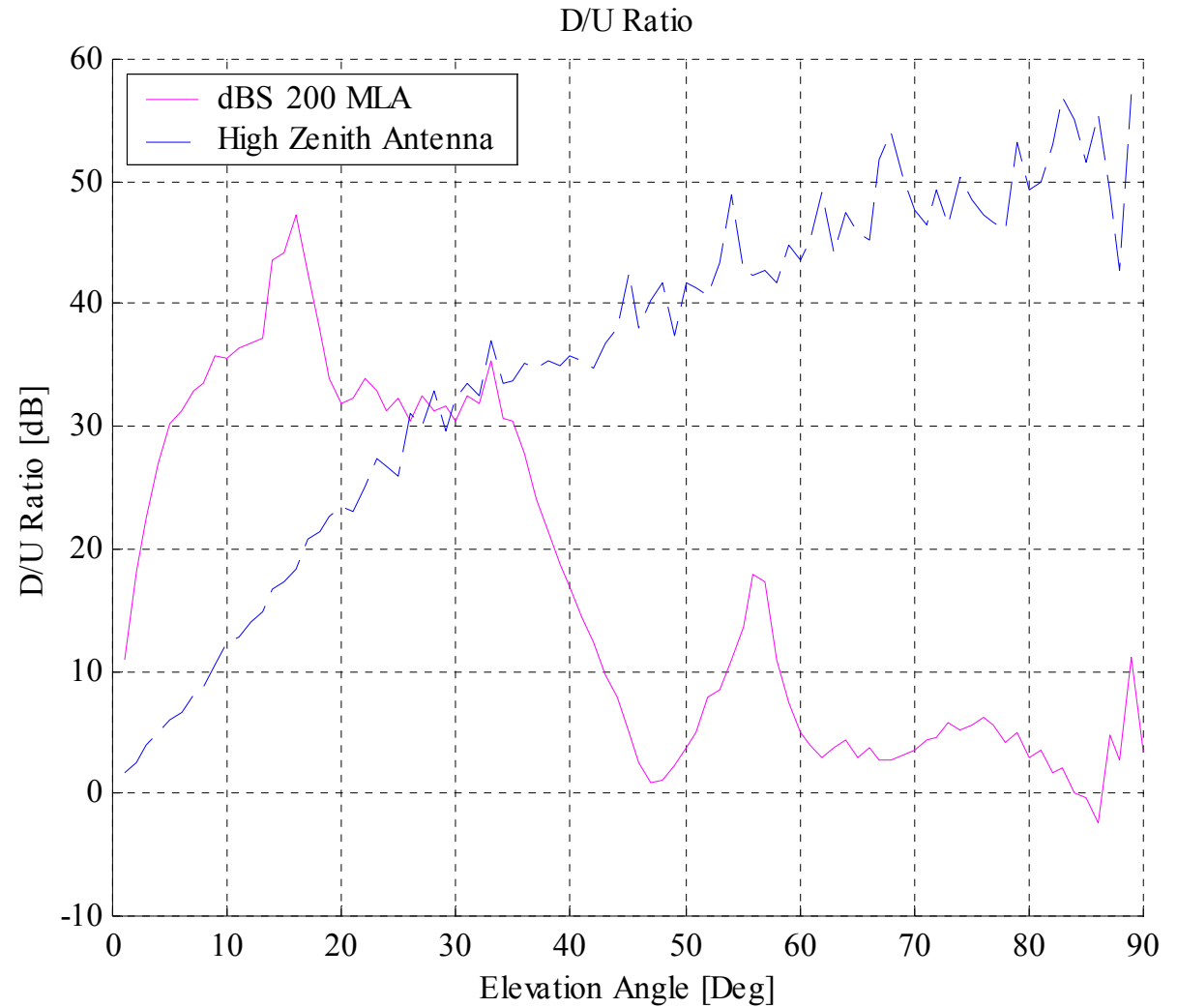
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LOCAL AREA AUGMENTATION SYSTEM (LAAS)



IMLA ANTENNA



Immediate Objectives

- **Simulate the effect of multipath from sloped ground**
- **Investigate effects of ground constitutive parameters on reflection coefficient and resulting errors**
- **Examine how phase center height (PCH) affects multipath envelope**



Long Term Objectives

- **Provide guidance materials to siting engineers**
- **Develop a more comprehensive MP model**



Description

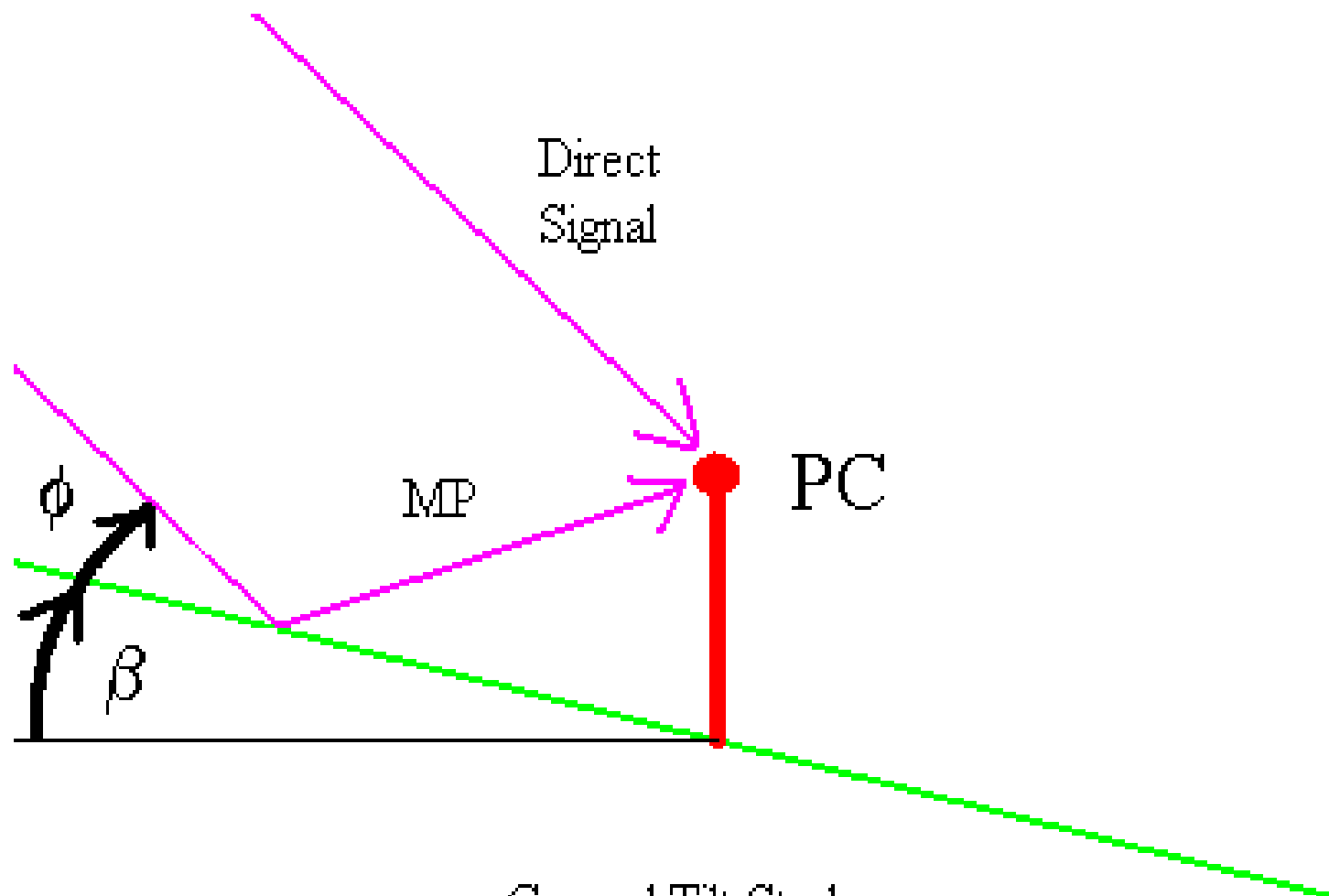
- **EM model to interface with OU receiver MP model**
- **Includes MLA 200 pattern data**
 - » **Developed by OU and dB Systems for LAAS**
- **Final results: smoothed PR error vs. satellite elevation**
 - » **Parametric search**



EM Model Inputs

- **Constitutive parameters of ground (average)**
 - » **Conductivity = 0.012 (S/m)**
 - » **Relative permittivity = 15**
 - » **Relative permeability = 1**
- **Ground tilt (-5 to 5 deg)**
- **Satellite elevation profile (initial, rate, final)**
- **PCH of antenna (3m to 15m)**





Ground Tilt Study:
Geometric Illustration

EM Outputs

- Relative strength of MP signal
- Phase difference
- Relative path delay
- Signal arrival angles
- 5Hz sampling frequency

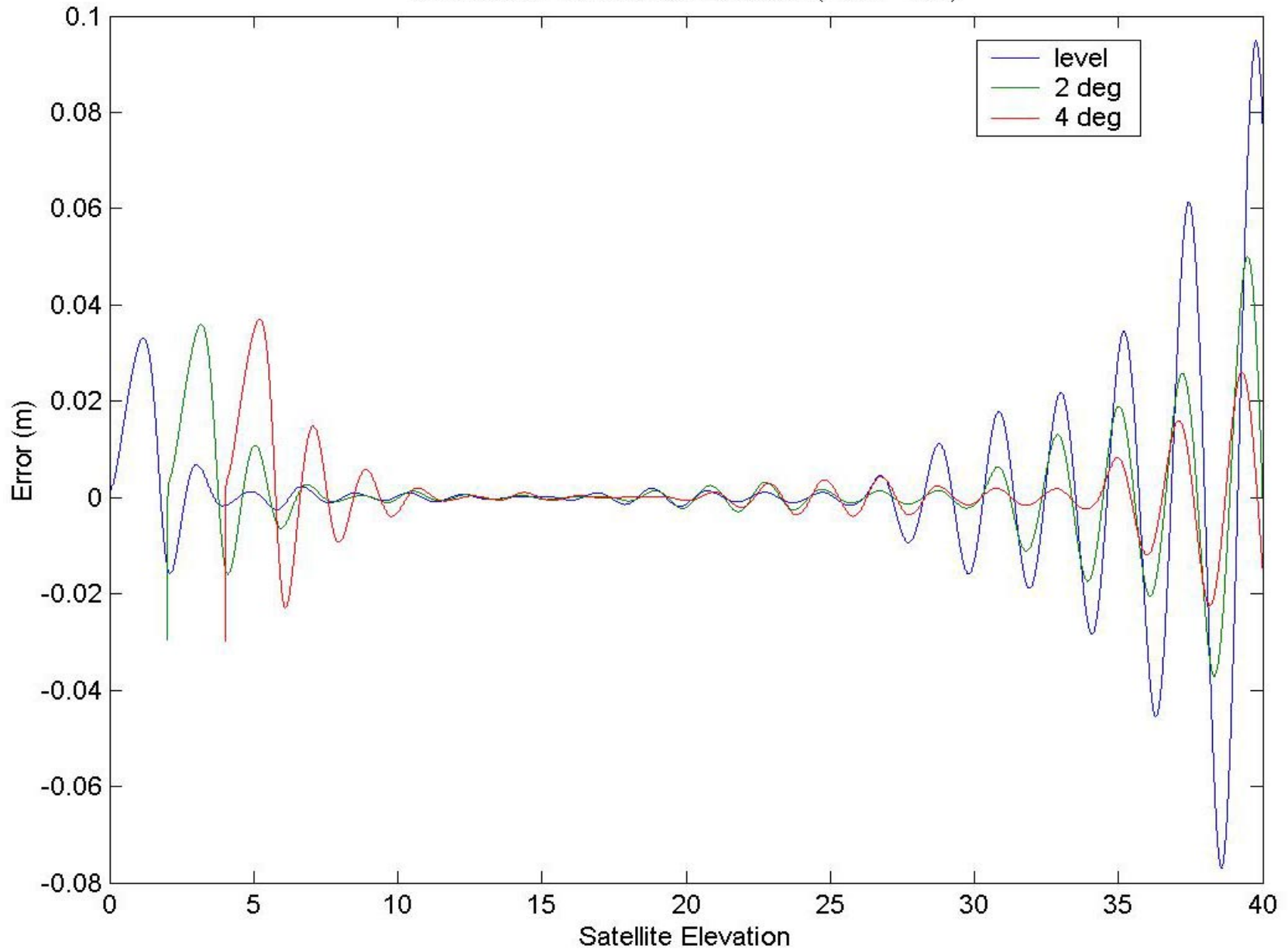


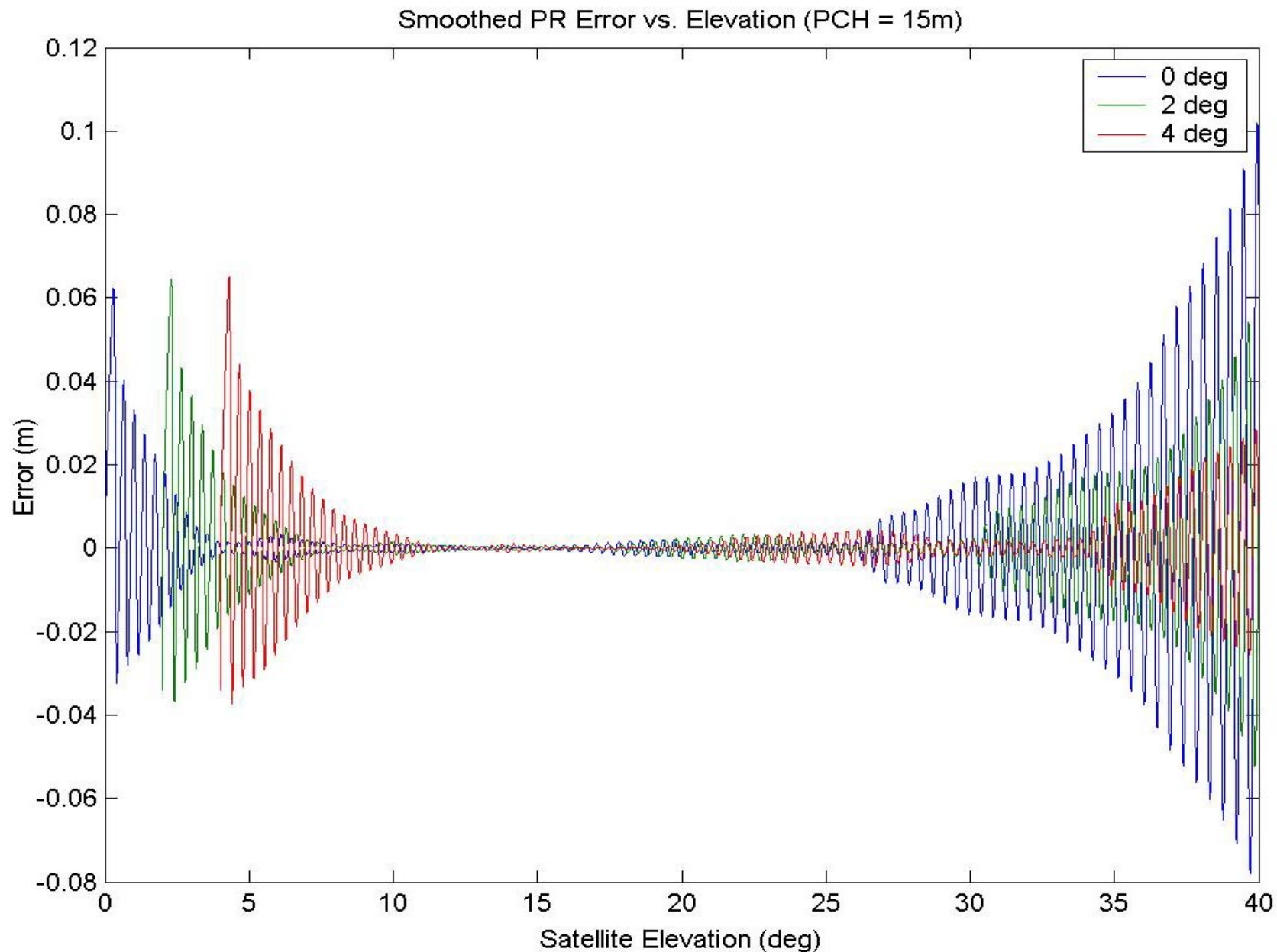
Receiver model

- **MLA pattern data used to compute relative signal strengths based on arrival angles**
- **Receiver model calculates smoothed PR error**
 - » **Causal**
 - » **Tracking loops modeled**
 - » **Narrow correlator, carrier smoothed**

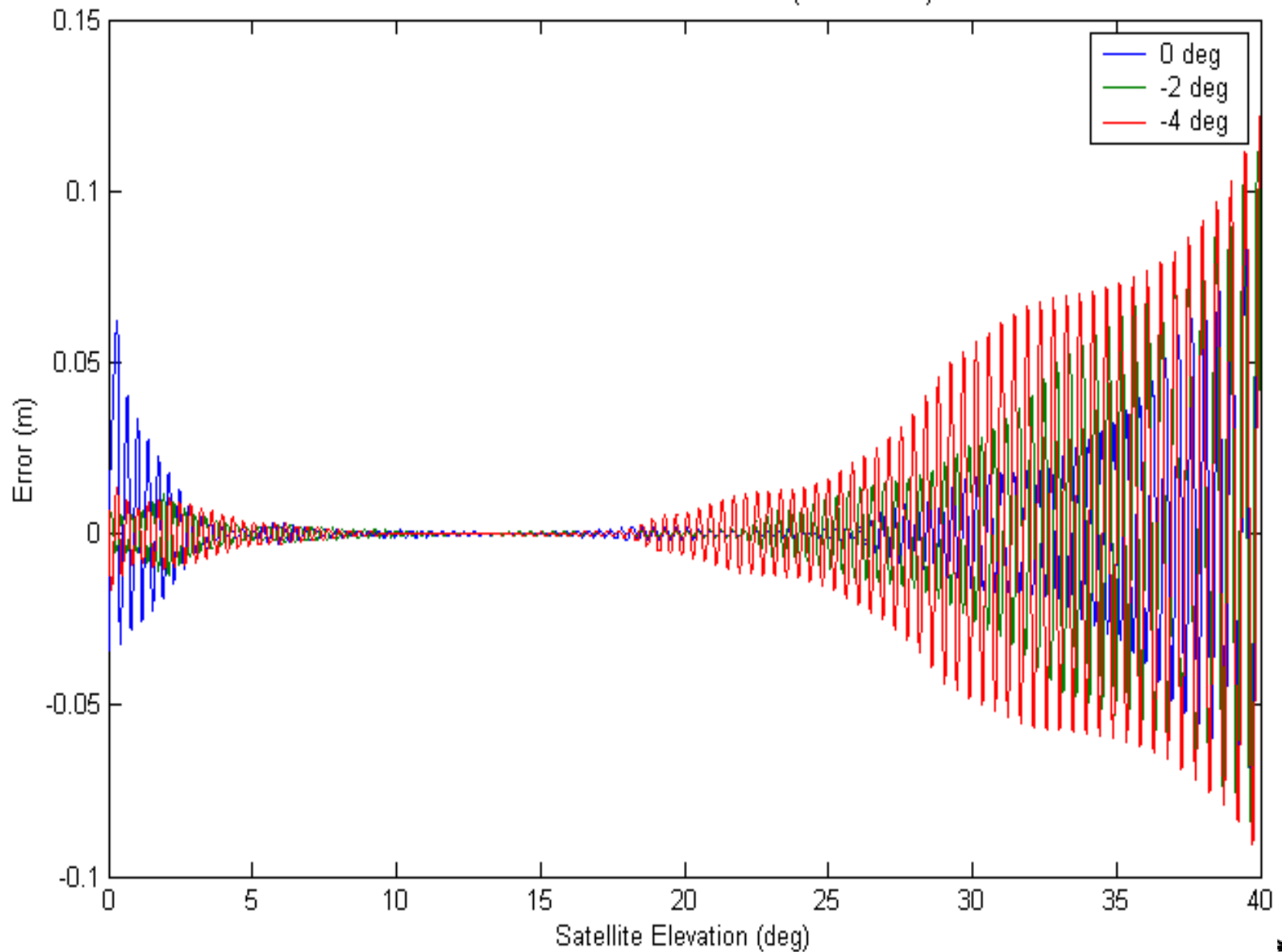


Smoothed PR Error vs. Elevation (PCH = 3m)





Smoothed PR Error vs. Elevation (PCH = 15m)



Note

- The objective of the investigation is to isolate the effects of tilted ground.
- Therefore, the following are excluded...
 - » Ionospheric distortions
 - » Near-field effects
 - » Phase center angular dependence
 - » Noise



Conclusions

- **Ground tilt shifts error envelope up by the tilt angle with some compression or expansion**
 - » Effects are well-behaved and change gradually
- **Higher PCH causes larger errors but faster oscillations, allowing more effective filtering**
- **Higher ground conductivity causes larger errors**

